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Form PTO-1390 (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**		ATTORNEY'S DOCKET NUMBER 130815.90026 US. APPLICATION NO. (If known, see 37 CFR1.5) 09/700447
INTERNATIONAL APPLICATION NO. PCT/US99/13145	INTERNATIONAL FILING DATE 11 June 1999 (11.06.99)	PRIORITY DATE CLAIMED 11 June 1998 (11.06.98)
TITLE OF INVENTION Direct Drive Inside-out Brushless Motor		
APPLICANT(S) FOR DO/EO/US Moe K. Barani, Ron Flanary and Lee Snider		

NOV 09 2000

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [X] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An unsigned oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information: Return postcard

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U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/700447	INTERNATIONAL APPLICATION NO. PCT/US99/13145	ATTORNEY'S DOCKET NUMBER 130815.90026

				CALCULATIONS	PTO USE ONLY
17. [X] The following fees are submitted: **BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):** Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... **$970.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... **$840.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... **$690.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... **$670.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$96.00**					
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 670.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	10 -20 =	0	X **$18.00**	$	
Independent claims	1 -3 =	0	X **$78.00**	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$	
Reduction by 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.429(f)). +				$	
TOTAL NATIONAL FEE =				$670.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$670.00	
				Amount to be: refunded	$
				Charged	$

a. [ ] A check in the amount of $ .00 to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. 17-0055 in the amount of $ .00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 17-0055 . A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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411 East Wisconsin Ave.
Milwaukee, WI 53202-4497

Michael J. McGovern
SIGNATURE

Michael J. McGovern
NAME

28,326
REGISTRATION NUMBER

4648682

09/700447
WO 99/65134 PCT/US99/13145
PTO/PCT Rec'd 09 NOV 2000

DIRECT DRIVE INSIDE-OUT BRUSHLESS ROLLER MOTOR

FIELD OF THE INVENTION

This invention relates to an improved motor driven roller in which the motor is located inside the roller and, more particularly, to such a motor driven roller in which the motor directly drives the roller.

DESCRIPTION OF THE PRIOR ART

Motor-driven rollers are used in a variety of applications. Among these applications are the rollers used in exercise treadmills and in material handling conveyors. The specific embodiment of the invention, described in this patent specification, is directed to a conveyor application. However, it will be appreciated the invention is applicable to motor driven rollers used in other systems, such as treadmills.

In a widely used prior art motor driven conveyor roller, a brushless, permanent magnet, d.c. motor is housed inside the roller itself. The motor, which is necessarily limited in size, has a relatively low torque. Typically, a conveyor roller has an inside diameter of less than two inches. A reducing gear is needed to couple the motor rotor to the roller in order to generate the torque required for the conveyor roller application. A resilient clutch is used to uncouple the motor from the roller in those situations where the roller becomes stuck. While generally satisfactory, the reducing gear requires maintenance and is subject to breaking down, which requires disassembly of the roller and repair or replacement of the broken parts.

SUMMARY OF THE INVENTION

An object of this invention is the provision of an electronically controlled, high torque d.c. motor assembly housed inside the roller and directly connected to it, which eliminates the need for a reduction gear and a clutch control used in the prior art.

Briefly, this invention contemplates the provision of a motorized roller in which a cylindrical permanent magnet is secured to the inside surface of the roller. Longitudinal segments are magnetized to form poles of alternate north and south magnetic polarity. These magnet poles are the rotor of an inside-out brushless d.c. motor, the stator of which is formed by coils in slots in a toothed structure mounted on a stationary shaft about which the permanent magnet rotor and the roller to which it is attached rotates. Preferably, the number of rotor poles is, or is close to, the maximum number of poles that can be formed about the circumference of the cylindrical permanent magnet, given the constraint on the diameter of the permanent magnet since it much fit within the roller, and the constraint of practical manufacturing limitations. Increasing the number of magnetic poles decreases the required thickness of the back iron which is needed to generate a high flux density in the air gap, which in turn is necessary to generate a high torque output per unit volume. It will be appreciated that the required back iron thickness is approximately equal to the ratio of the number of magnetic flux lines per pole to the acceptable back iron flux density level. As the number of poles increases, the magnetic lines per pole decrease, since the magnetic flux is evenly distributed among the poles.

The stator coils are electronically commutated to provide brushless operation. One end of the stator shaft extends beyond the end of the roller and is secured to a suitable frame member. Wires in a passage in the shaft

carry current to the coils. Preferably, six-step switching is used to commutate the stator coils and the commutation angle can be advanced as the motor speed increases in order to maintain a desired torque. In one embodiment, the motor extends the length of the roller. In another embodiment, the motor extends for only a part of the length of the roller. The permanent magnet in which the poles are formed may be secured to the inside of the roller by means of a suitable adhesive. Here, the roller itself serves as the back iron to provide a low reluctance path to complete the magnetic circuit between adjacent poles. In another embodiment, the entire motor assembly is secured in a metal housing, which is then secured to the roller by force fit or other suitable means. Here the metal housing serves as the back iron member.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of a preferred embodiment of the invention in which:

Fig. 1 is a longitudinal, sectional view of one embodiment of motor and roller combination in accordance with the teachings of the invention.

Fig. 1A is a transverse sectional view taken in the plane indicated by line 1A--1A in Fig. 1.

Fig. 1B is an enlarged fragmentary view of a portion of Fig. 1A.

Fig. 2 is a longitudinal, sectional view of a second embodiment of the motor and roller combination in accordance with the teachings of the invention.

Fig. 2A is a transverse sectional view taken in the plane indicated by line 2A--2A in Fig. 2.

Fig. 3 is a schematic view of a modified form of the roller and motor combination of either Fig. 1 or Fig. 2 in

which the motor extends for only a part of the length of the roller.

Fig. 4 is a schematic view similar to Fig. 3 where the motor extends substantially the entire length of the roller.

Fig. 5 is a schematic drawing of a control system for the roller motor of a conveyor roller driven by an inside-out, brushless, permanent magnet, d.c. motor in accordance with the teachings of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figs. 1 and 1A, in this embodiment of the invention, a cylinder 10 having a plurality of permanent magnets 12 is secured to the inside surface of a conveyor roller 14 by a suitable adhesive, for example. The thickness "t" of a typical conveyor roller wall is approximately roughly 1/16 of an inch. The permanent magnets 12 may be of any suitable magnetic material, such as neodium-iron-boron. As illustrated in Fig. 1A, longitudinal segments 12 of the cylinder 10 are magnetized to form magnetic poles with adjacent segments of opposite magnetic polarity, as indicated by the letters N and S in Fig. 1B. The magnetized segments 12 are separated by narrow gaps of material 13 that are not magnetized under ordinary operating conditions. Since the magnetic flux generated by the cylinder 10 is a function of its surface area (i.e. Magnetic Flux = Magnetic Flux Density X Magnet Area), it will be appreciated this configuration provides a large magnetic surface area and hence a large magnetic flux.

A laminated toothed member 16, which is affixed to a shaft 18, is separated from the inner surfaces of cylinder 10 by an air gap 19. Stator coils 15 are disposed in slots 22 formed by teeth 26. The coils 15 each have at least thirteen turns, with only one turn per coil being shown for illustration purposes. Each coil 15 encircles

only a single tooth 26. The coils 15 carry current supplied in three phases, A, B and C. In a preferred embodiment of the invention, a three-phase stator is used, with four coils per phase and two coil half-sections in each slot 22. Slot 1 is designated S1 in Figs. 1A and 2A. Slot 1 is located between "tooth 12" and "tooth 1" of the stator 16. The phase A coils are disposed in the slots 22 to encircle "tooth 12" ,"tooth 1", "tooth 6" and "tooth 7." The phase B coils are disposed in the slots 22 to encircle "tooth 2", "tooth 3", "tooth 8" and "tooth 9". The phase C coils are disposed in the slots 22 to encircle "tooth 4", "tooth 5", "tooth 10" and "tooth 11".

The motor of the present invention develops a high back EMF so as to provide a higher ratio of stator voltage to rotor speed than the prior art. In the prior art, this ratio was about 1.5. In a preferred embodiment, according to Fig. 3, in which the stator is three inches long, and in which each stator coil has at least 13 turns of 21 AWG guage wire per coil, a ratio of 10 RMS volts per 1000 RPM of rotor speed can be obtained, with the nominal stator voltage on each of the three phases being a 24-volt RMS PWM signal. By varying the number of turns, other guages of wire will provide the same results. If the nominal stator voltage were doubled to 48 RMS volts, then this ratio would be doubled to 20 RMS volts per 1000 RPM to provide suitable performance.

The coils are electronically commutated, for example, by a six-step commutation control algorithm. Although six-step commutation is preferred, other types of commutation including sine wave commutation may be employed. Here it will be appreciated this brushless commutation requires a means to determine the angular position of the rotor with respect to the stator coils 15. Three Hall effect sensors 23 are angularly spaced 120° apart and are supported on an annular circuit board 20. As the pole segments 12 pass by, sets of three signals are provided from the Hall effect sensors 23, and these three-signal sets are decoded to

determine angular position signals which are then used for controlling commutation.

The number of pole segments 12 is preferably made as large as it is practical to manufacture without reducing the magnetizable area. For example, with the inside diameter of the magnetic cylinder 10 on the order of one inch, it is practical to form about twelve pole piece segments. By increasing the number of poles, for a given flux density, the thickness of the back iron required of a low reluctance magnetic flux return path is decreased so that the roller 14 can provide this function, resulting in an increased torque output per unit volume. As the number of poles increases, the flux lines per pole decreases, since the density is distributed evenly among the number of poles. Consequently, the thickness of the back iron decreases as the number of poles increases. The minimum number of poles for any motor is two. The ratio of the back iron thickness for a two pole to the back iron thickness for a motor with "N" poles is approximately N divided by 2. In order to keep the overall diameter of the motor sufficiently small to fit inside the rollers, while at the same time generating sufficient torque directly to drive the motor, at least six poles and preferably ten poles (as illustrated) should be used.

The shaft 18 extends outwardly from the roller so that it can be secured to the frame of the conveyor. The outer peripheral surfaces of a pair bearings 30 and 32 at this end of the shaft are affixed to the inner surface of the roller 14. The outer peripheral surface of another bearing 34, at the other end of the shaft 18, is also affixed to the inner surface of the roller 14. These bearings are all rotatably mounted on the shaft 18 and allow the permanent magnet 10 along with the roller 14 to which it is affixed to rotate relatively to the fixed shaft 18 while maintaining the air gap 19 between the inner surface of the magnets and the outer periphery of toothed member 16. Conductors 37 are disposed in a passageway 36 in the shaft

18, including three phase conductors to provide power to the stator coils 15 from an external power source.

Referring now to Figs. 2 and 2A, in which like reference numbers have been used to designate like parts in Fig. 1, in this embodiment of the invention, the roller motor is first assembled in a cylindrical metal housing 40 which, in turn, is secured to the inner surface of the roller 14. The thickness of the wall of the housing is preferably minimized in order to maximize the diameter of the cylinder 10 which in turn maximizes torque. In a preferred embodiment, the housing 40 is secured to the roller 14 by a forced friction fit between the outer surface of the housing 40 and the inner surface of the roller 14 for at least a portion of their lengths. That is, the nominal outside diameter of the housing is slightly larger than the nominal inside diameter of the roller for at least a portion of their lengths. The housing 40 is closed at one end and a bearing 42 rotatably supports this end of the housing on the shaft 18. In lieu of the press fit, adhesive may be used to secure the housing 40 to the roller 14, or the adhesive may be used in addition to the press fit. In this embodiment of the invention, the housing 40 provides the back iron path for the pole segments 12.

Referring now to Fig. 3, in one embodiment of the invention the motor (here indicated by the reference number 46) extends only for part of the length of the roller 14, which is supported by frame members 48. The shaft 18 in this embodiment needs to extend the length of the roller, but may be supported by a bearing 47 inside the roller. The other side of the roller 14 is supported by a shaft 49 affixed to the frame 48 and a bearing 50 rotatable about the shaft and affixed to the roller 14.

In the embodiment of Fig. 4, the motor 46 does extend substantially the entire length of the roller. Here it will be appreciated the volume of the motor increases, and

the torque which it can generate, which is a function of volume, also increases.

Fig. 5 is a schematic diagram illustrating one embodiment of how the roller motor can be energized. Here a six-step commutating controller 52 connects a three-phase power supply 54 to the motor's stator coils (shown in Figs. 1 and 2) through three phase conductors 55 entering through the shaft of the roller 14. The rotor position sensors 23 (for example a Hall effect sensor) (shown in Figs. 1 and 2) provide commutating signals to controller 52 through three sense lines 57. A current sensing line 56 provides a signal to the controller 52 to indicate when a roller is stuck (i.e. the input current excess a predetermined threshold) so that the controller can cut off power to the jammed roller. If desired, the controller 52 can provide short duration power pulses to the motor after power has been cut off, to see if the roller has become freed, and if it has to resume supplying power to the motor.

While the invention has been described in terms of a single preferred embodiment, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the appended claims.

CLAIMS

We claim:

1. A motor for driving a cylindrical roller that rotates around a stationary shaft, the motor being characterized by:

a cylindrical rotor disposed inside of and mounted to rotate with said cylindrical roller around said stationary shaft;

wherein said rotor is formed of a plurality of longitudinal segments of permanent magnetic material, wherein said segments alternate orientation of north-south magnetic polarity in a radial direction to produce flux in flux path loops connecting pairs of the longitudinal segments; and

a plurality of stator coils mounted on said shaft for receiving current from an external power supply that commutates current in said stator coils; and

further characterized in that said motor is a brushless d.c. motor; and

further characterized by means supported by the stator shaft for sensing position of the rotor with respect to said stator shaft.

2. The motor of claim 1, further characterized by:

a cylindrical metal housing which forms a part of the rotor for receiving the segments of permanent magnetic material and for supporting the shaft and the stator coils in a motor assembly; and

further characterized in that said motor assembly is disposed inside of and secured to said roller.

3. The motor of claim 2, further characterized in that said motor assembly is secured to said roller at least in part by a force fit of the cylindrical metal housing inside said roller.

AMENDED SHEET

4. The motor of claim 1, 2 or 3, further characterized in that said rotor and said plurality of stator coils extend part way in an elongated direction of said roller.

5. The motor of claim 1, 2 or 3, further characterized in that said rotor and said plurality of stator coils extend substantially an entire length of said roller.

6. The motor of claim 1 or 2, further characterized in that said plurality of poles includes at least six poles formed in said cylindrical member as longitudinal segments with segments of alternating north-south magnetic polarity with said roller providing a magnetic path between segments.

7. The motor of claim 1, 2 or 3, further characterized in that said rotor is connected to directly drive said roller without the use of a reduction gear assembly.

8. The motor of claim 1 or 2, further characterized in that the stator coils are formed of a sufficient number of turns of a sufficiently narrow guage wire to produce a ratio of stator voltage to speed of at least 10 RMS volts per 1000 RPM for an applied stator voltage of 24 RMS volts per phase.

9. The motor of claim 8, wherein the stator has a plurality of teeth, and further characterized in that each stator coil encircles a single stator tooth.

10. The motor of claim 1 or 2, further characterized in that the sensor means is a sensor for detecting a rotational position of the rotor.

FIG. 1

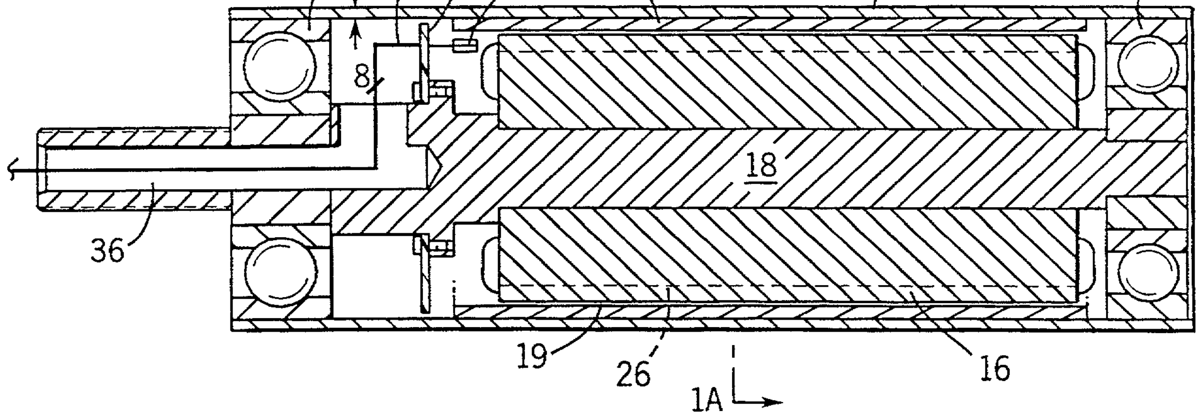
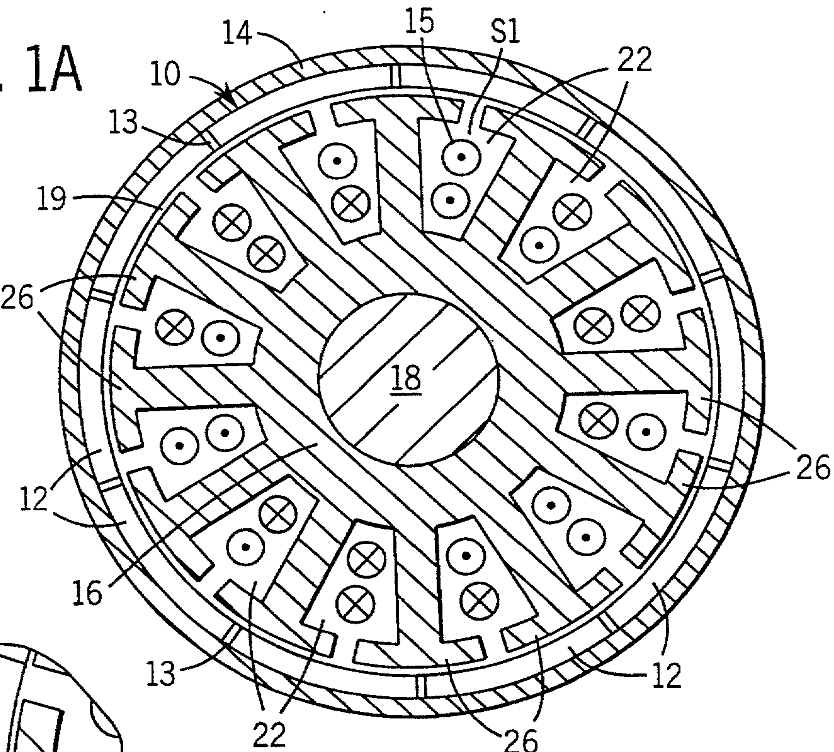


FIG. 1A



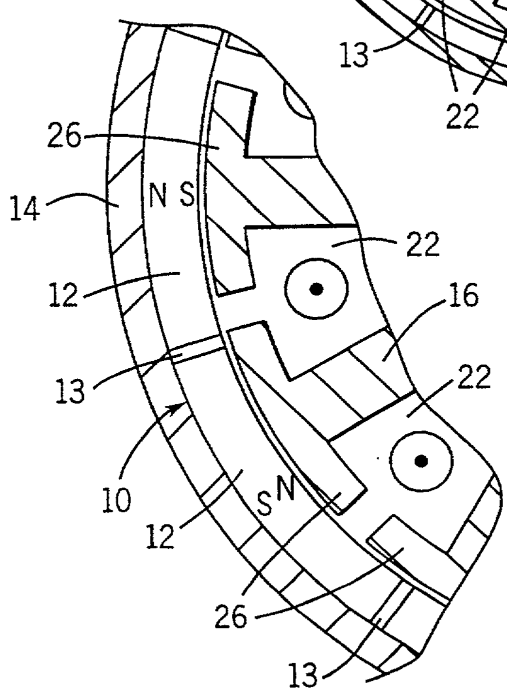


FIG. 1B

FIG. 2

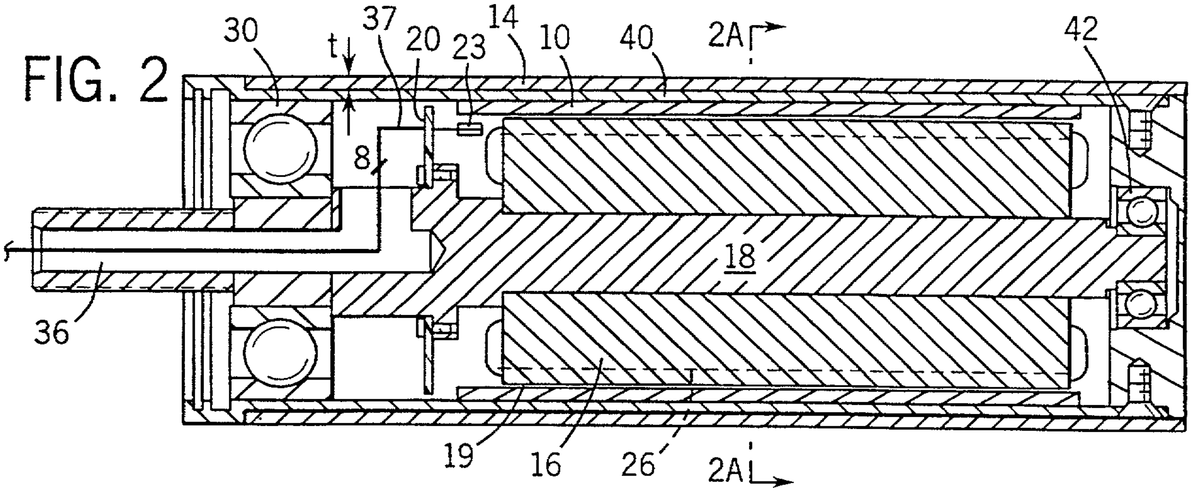

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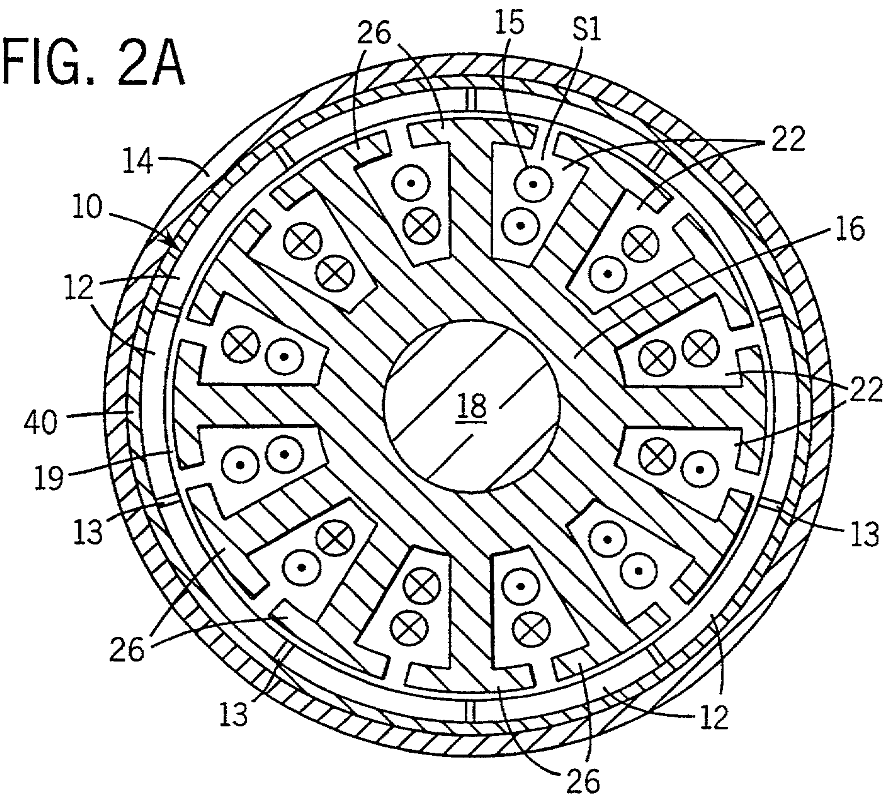
FIG. 2A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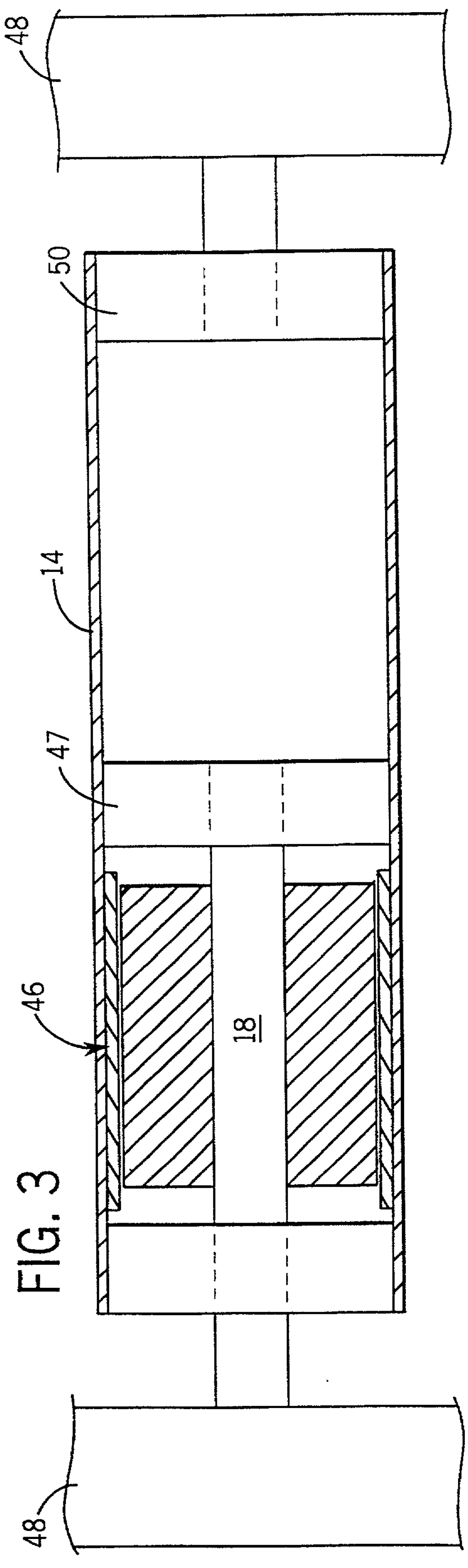


FIG. 3

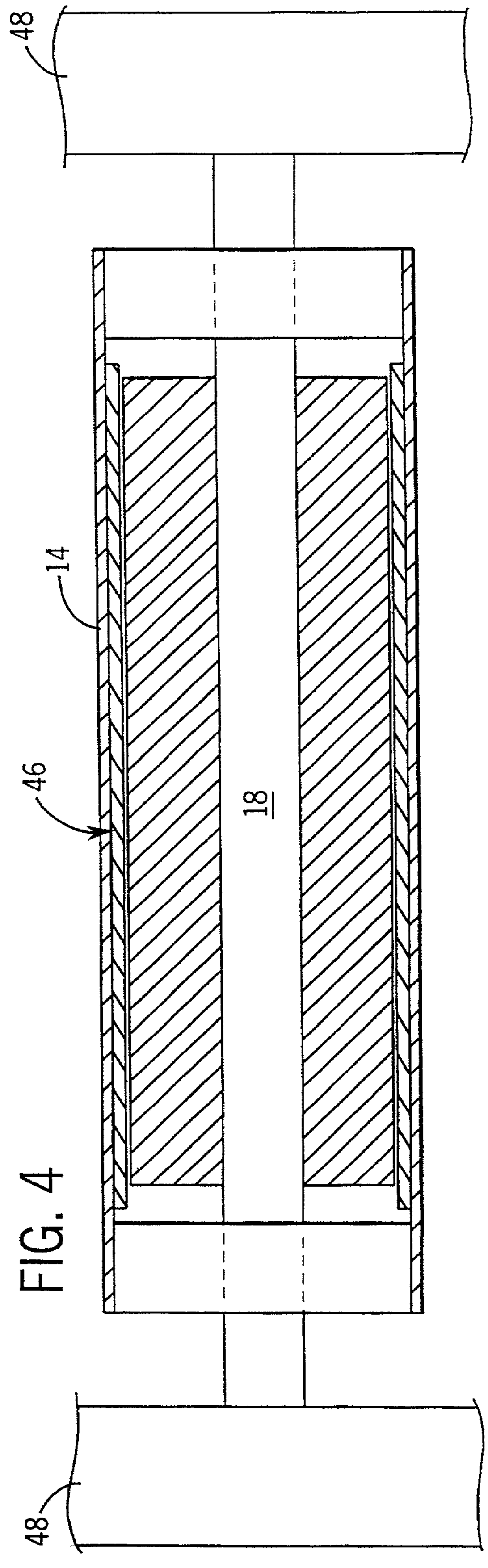
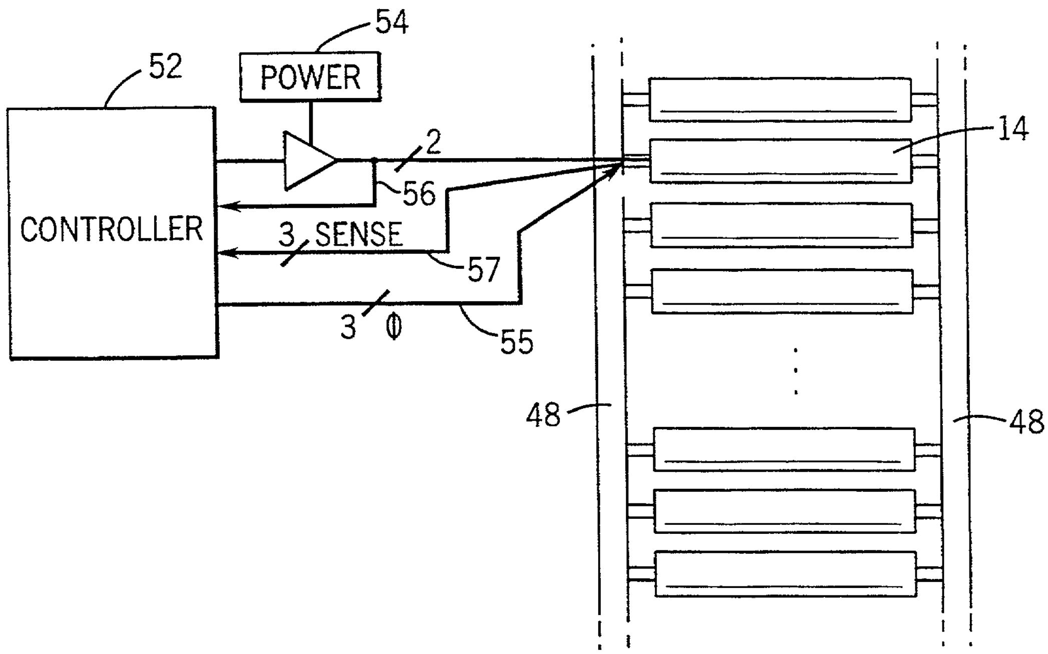


FIG. 4

FIG. 5



PTO/SB/01 (6-95)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Rev. 6/95

U.S. Department of Commerce
Patent and Trademark Office

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION

[ ] Declaration Submitted with Initial Filing OR [X] Declaration Submitted after Initial Filing

Attorney Docket Number	130815.90026
First Named Inventor	Barani
COMPLETE IF KNOWN	
Application Number	09/700447
Filing Date	November 9, 2000
Group Art Unit	--
Examiner Name	--

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Direct Drive Inside-Out Brushless Motor

(Title of the Invention)

the specification of which

[ ] is attached hereto

OR

[X] was filed on (MM/DD/YYYY) 10/11/2000 as United States Application Number or PCT International Application Number 09/700447 and was amended on (MM/DD/YYYY) [ ] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[ ] Additional foreign applications numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
60/088,856	06/11/1998	[ ] Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

Burden Hour Statement: This form is estimated to take .4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231. 4648891

Please type a plus sign (+) inside this box [+]

DECLARATION

I hereby claim benefit under Title 35, United States Code §120 of any United States application(s), or §365(C) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application or PCT international application in the manner provided in the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
09/166,139		10/02/1998	

[ ] Additional U.S. or PCT international application numbers are listed on a supplemental priority sheet attached hereto

As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and all continuation and divisional applications based thereon, and to transact all business in the Patent and Trademark Office connected therewith:

[ ] Firm Name [ ] Customer Number or label [ ]

OR

[X] List attorney(s) and/or agent(s) name and registration number below

Name	Registration Number	Name	Registration Number
Michael J. McGovern	28,326	Michael A. Jaskolski	37,551
Carl R. Schwartz	29,437	Richard T. Roche	38,599
Keith M. Baxter	31,233	John T. Pienkos	42,997
John D. Franzini	31,356	Daniel G. Radler	43,028
Jean C. Baker	35,433	Steven J. Wietrzny	44,402
David G. Ryser	36,407		

[ ] Additional attorney(s) and/or agents named on a supplemental priority sheet attached hereto

Please direct all correspondence to [ ] Customer Number or label OR [X] Fill in correspondence

Name	Michael J. McGovern				
Address	Quarles & Brady LLP				
Address	411 East Wisconsin Ave. Suite 2040				
City	Milwaukee	State	WI	Zip	53202-4497
Country	USA	Telephone	414) 277-5000	Fax	(414) 271-3552

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Name of Sole or First Inventor: [ ] A petition has been filed for this unsigned inventor

Given Name	Moe	Middle Initial	K.	Family Name	Barani	Suffix e.g. Jr.	
Inventor's Signature	Moe K. Barani					Date	1-25-01
Residence:	Radford	State	VA	Country	US	Citizenship	US
Post Office	104 Mountain View Lane US						
Post Office							
City	Radford	State	VA	Zip	24141	Country	United States
Applicant Authority							

[X] Additional inventors are being named on supplemental sheet(s) attached hereto

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Please type a plus sign (+) inside this box [+]

DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet

2-D

Name of Additional Joint Inventor, if any:			A petition has been filed for this unsigned inventor				
Given Name	Ron	Middle Initial	-	Family	Flanary	Suffix e.g. Jr.	
Inventor's Signature	Ron Flanary					Date	1-23-01
Residence:	Blacksburg	State	VA	Country	US	Citizenship	US
Post Office	295 Deercroft Drive US						
Post Office							
City	Blacksburg	State	VA	Zip	24060	Country	United States
Applicant Authority							

3-D

Name of Additional Joint Inventor, if any:			A petition has been filed for this unsigned inventor				
Given Name	Lee	Middle Initial		Family Name	Snider	Suffix e.g. Jr.	
Inventor's Signature	Lee Snider					Date	1-23.01
Residence:	~~Christiansburg~~	State	VA	Country	US	Citizenship	US
Post Office	3635 Fairview Church Road US						
Post Office							
City	Christiansburg	State	VA	Zip	24074	Country	US
Applicant Authority							

Name of Additional Joint Inventor, if any:			A petition has been filed for this unsigned inventor				
Given Name		Middle Initial		Family Name		Suffix e.g. Jr.	
Inventor's Signature						Date	
Residence:		State		Country		Citizenship	
Post Office							
Post Office							
City		State		Zip		Country	
Applicant Authority							

Name of Additional Joint Inventor, if any:			A petition has been filed for this unsigned inventor				
Given Name		Middle Initial		Family Name		Suffix e.g. Jr.	
Inventor's Signature						Date	
Residence		State		Country		Citizenship	
Post Office							
Post Office							
City		State		Zip		Country	
Applicant Authority							

[ ] Additional inventors are being named on supplemental sheet(s) attached hereto

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